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Self-efficacy in product development student teams - what shapes students' perceived self-efficacy

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Abstract

This paper aims to provide a perspective of the student's perceived self-efficacy in a team based project course where students face open-ended, ill-defined problems. We discuss the development of self-efficacy in the team members and how different situations and events affect their perceived self-efficacy. The data used in this paper was gathered through interviews from students taking a yearlong masters' level capstone course. Results of the study show that the students' overall self-efficacy increased most in team-based moments. We show also how entrepreneurial self-efficacy of students can be enhanced during problem-based New Product Development process. Finally we will conclude the potential of the researched course to provide practical experiences of project work as well as its potential for delivering entrepreneurial skills for the students during their education.

Keywords: *Self-efficacy, Product development, Entrepreneurship, Teamwork*

1 Introduction

In the world of wicked problems and globalization, there is a growing demand for educational methods training students to face real life challenges (Ulrich & Eppinger, 1995). While students might be adequately informed of their disciplinary knowledge, they still often fall short in the thinking and working skills needed in the complex and multidisciplinary real-world work environments. Better connection between knowledge and the context of its application along with the development of the skills required to tackle the ill-defined, complex design problems are called for (Laakso & Clavert, 2014). This paper examines self-efficacy and entrepreneurial motivation theories and presents a study conducted with students taking part in a capstone course that consists of completing an international, interdisciplinary team-based product development project. We discuss self-efficacy as the underlying fundamental of design thinking. Additionally we look into entrepreneurial intention and motivation theories as the foundation for entrepreneurial thinking and behavior. Current research in self-efficacy is used as a basis for discussion to understand the roles of perceived

self-efficacy and development of entrepreneurial behavior in product development work and also how they help practitioners to understand how the abovementioned skill- and knowledge-based challenges can be tackled (Laakso & Clavert, 2014).

The studied course is an open-ended one academic year long Master's level course in product development major. Product development process is seen very similar to new venture creation process (Ulrich & Eppinger 1995). Both processes include *opportunity identification, benchmarking & need finding, market research and validation, prototyping and user testing*. Entrepreneurs often reflect these early phases of the process being stressful and related to feelings of uncertainty (Barbosa et al., 2007; Izquierdo et al., 2011). The course is run by Aalto University and it has been conducted for 19 years. The educational methods used in the course are a variation of project oriented problem-based learning and the course curriculum follows a design thinking innovation process coupled with traditional processes. The data used in this study was gathered through thematic semi-structured interviews in the academic year of 2014-2015, from nine students in three teams. The main research interest was to find out in what kinds of situations affect the self-efficacy of team members during new product development process and how interaction and emotions affect team member's self-efficacy beliefs during new product development process. Self-efficacy is understood in this context as a generalized concept for both creative and entrepreneurial self-efficacy and it is further discussed in the next chapter.

The findings between the relationship of design thinking, entrepreneurial motivation and self-efficacy suggest that students go through emotional processes influencing self-efficacy especially in the phases of *team formation, background research, and concept creation* as well as during events like *workshops* and *building the final prototype*.

1.1 Self-efficacy and Entrepreneurial motivation

Self-efficacy reflects domain-specific individual beliefs that one able to perform a certain action successfully (Bandura, 1982). It is linked with motivational outcomes such as initiating and sustaining activities and levels of effort expended towards the activity (Zimmerman 2000). Self-efficacy has been identified as an important factor in both academic performance (Chemers et al 2001) and product development efforts (Björklund, 2010). According to Bandura's theory (1997), individuals' development of self-efficacy is affected by four different factors. These are; 1) Enacted mastery experiences, 2) Vicarious experiences, 3) Social persuasion and 4) Emotional & physiological arousals (Bandura, 1997).

According to Bandura (1977) *enacted mastery* experiences refer to individual's former experiences that affect a person's behavior. This means the individual assesses his ability to act basing on the reflection of these experiences and former positive experiences of success enhance individual's self-efficacy beliefs.

Vicarious experiences refer to social comparison. These experiences occur when an individual compares his or her own skills to so called reference targets. People often compare themselves to other people that are in similar situations as they themselves are. Therefore, the self-efficacy beliefs of an individual tend to increase in case the individual thinks that he is more capable to succeed in the task than the reference group that he compares himself to. The effect of vicarious experiences depend on both the individuals capability to evaluate the skills and performance of the reference group as well as from the evaluation of own skills and competences (Bandura, 1977).

Social persuasion refers to the encouragement or discouragement that an individual receives from another person. Positive encouragement or feedback that is received from a relatable person often leads to an increase of self-efficacy. Social persuasion works both ways meaning that negative feedback or discouragement weakens the self-efficacy beliefs. Bandura (1997) states that negative persuasion has a stronger effect compared to encouragement. Bandura also states that positive encouragement has to be realistic and it is mostly effectual to those who constantly aim to higher performance levels (Bandura, 1997).

Lastly, *emotional and physiological arousals* refer to responses such as fear, anxiety or stress that the individual experiences in different situations and environments. Powerful emotional and psychological arousals can potentially have strong influence on self-efficacy beliefs. As an extreme case those responses can produce condition such as *avoidance behavior* that refers to active or passive resistance to complete certain tasks due to negative emotions. Behavioral avoidance also called *learned helplessness* occurs in situations where individual avoids even trying or starting the process of completing task due to his or her feeling of not having required skills or other capabilities (Bandura, 1977). In contrast to learned helplessness, learned optimism refers to situations where one intends to face challenging situations with optimistic mindset (Seligman, 1991).

These four factors affect both the perceived self-efficacy of individuals as well as the collectively perceived self-efficacy of teams. Figure 1 below depicts the process of different factors affecting one's self-efficacy beliefs that in the end leads to change in behavior and finally in performance.

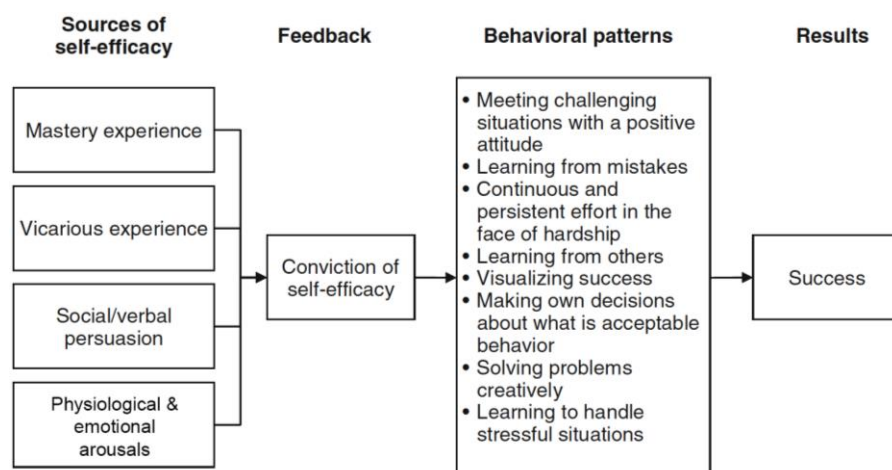


Figure 1. General model for successful training of self-efficacy according to Carsrud et. al. (2009).

1.2 Design thinking, problem based learning and entrepreneurial intentions

Design thinking has been widely discussed in educational, managerial and product development contexts in recent years (Brown 2008, Kirjavainen & Björklund 2011). Design thinking has been defined in multiple ways, but what studies are unanimous in is, that design thinking is a combination of thinking and acting in solving ill-formed problems (Hassi & Laakso, 2011). Design thinking is a combination of cognitive processes, mindset, practices and action (Cross, 2006). We understand design thinking as being closely linked to one's perceived self-efficacy, as a "can-do" attitude, high tolerance for ambiguity and a will as well as a belief that one can solve wicked problems (Buchanan, 1992).

A vast amount of research has been carried out to discover the relation of self-efficacy to entrepreneurial behavior and intentions (e.g. Barbosa et al., 2007; Izquierdo et al., 2011). Even though self-efficacy and its relation to entrepreneurial intentions has been commonly accepted, researchers have had a hard time specifying the exact mechanisms on how behavioral changes lead to events that enhance entrepreneurial mindset (Pihie & Bagheri, 2012). Entrepreneurial intentions mean the *capability and willingness to start a venture* and it consists of organizational and individual factors (Lee et al., 2011). Entrepreneurial behavior refers to one's capabilities in recognizing and exploiting discovered opportunities when creating new ventures and products and the cognitive state prior to action (e.g. Bird & Schjoedt, 2009; Carsrud & Brännback, 2009).

From the perspective of activities, practice and methodology a link can be seen between design thinking and entrepreneurial behavior. A person with entrepreneurial mindset tolerates ambiguity and can take carefully calculated risks in potential opportunities. This is in line with design thinking literature (McGrath & MacMillan, 2000). Studies on entrepreneurship have focused on psychological aspects of entrepreneurial mind including its affect on behavior (Carsrud & Brännback, 2009). Chen et al. (1998) found, that entrepreneurial self-efficacy is the main requirement for entrepreneurial intentions and that the most important factors that differentiate entrepreneurs from managers are the ability to innovate and the willingness to take risks (Chen et al., 1998).

1.3 Context of the study

Product Development Project-course, is an interdisciplinary product development course primarily targeted for master's level students from any academic field. It has been running since 1997. Product design methods used in the course are mainly based on linear product design and development model (Ulrich & Eppinger, 1995). The student teams are not however obligated to follow any particular model of PD process and teams often adapt more iterative models (e.g. Larman, 2010) including design-thinking activities. During the course, student teams tackle product design problems set by sponsoring industry partners. In addition, teams also include 1 to 4 students that are located in partner universities abroad. PDP lasts for the whole academic year and is based on self-organized teamwork. In practice about 9 months and students are awarded 10 ECTS (European Credit Transfer System) for successfully passing it. In addition, the project manager gains 2 ECTS points extra.

2 Methods and Data

The data was gathered from 9 interviews of students taking part in PDP. Three team members, the project manager and two members from three different teams were interviewed from the perspective of perceived self-efficacy. In addition to the interviews the participants were asked to mark the most remarkable events, both good and bad, to a sheet of paper showing the timeline of the entire course. The interviewees were also asked to visualize different phases of the project in terms of motivation and enthusiasm. This was done to enhance discussion about the topics and to gain better understanding of one's motivation and emotions during the project. The interviews, lasting from 62 minutes to 86 minutes and averaging at 73 minutes, were audio recorded and transcribed from word to word.

The segmented data was analyzed multiple times in an iterative and cyclical process using thematic analysis (Miles & Huberman, 1994). The coding had both deductive and inductive phases. The mass of "raw" transcribed data was first split into separate events in chronological order out of which preliminary notes were made. The analysis perspective was grounded to Bandura's theory of self-efficacy. Theory-driven coding was used on the first

level breakdown of the data to find out and reflect on *mastery experiences, vicarious experiences, social persuasion and physiological and emotional arousals* (Bandura, 1977, 1997).

3 Results

In this section we present the main categories resulting from the data analysis (see table 1). The categories were mutually exclusive except for category 4 (physiological & emotional arousals) in which all the segments reflect also multiple other categories.

Table 1. Sources of perceived self-efficacy during the PDP –course.

SOURCE OF SELF - EFFICACY (first-level code)	MAIN THEME	Mentions	DESCRIPTION OF CATEGORIES
Mastery experience	Former mastery experience	12	Confidence affected by former experiences of success or failure
	Soft skill mastery	56	Success or failure in mastery of soft skills during the project (e.g. storytelling, creativity methods, time management)
	Hard skill mastery	28	Success or failure in mastery of hard skill during the project (e.g. prototyping, coding, building)
	Collective soft skill mastery	50	Collective experience of success or failure in mastery of soft skill
	Collective hard skill mastery	17	Collective experience of success or failure in mastery of hard skill
Vicarious experience	Comparison of capability	21	Estimation of success or failure by comparing skills, working methods or team dynamics
	Comparison of attitude	28	Estimate of success or failure by comparing activity, commitment and contribution
	Comparison of performance	15	Estimate of success or failure by comparing progress, speed and gained results
Social persuasion	Direct feedback	46	Direct verbal feedback, support or criticism
	Indirect feedback	34	Non verbal feedback, support or criticism (communicated e.g. through actions, behavior and body language)
	Lack of feedback	19	Positive or negative perception of nonexistent feedback, support or criticism
Physiological & emotional arousals	Emotional responses	Linked to others	Emotional reactions to experiences (e.g. frustration, anger or excitement)
	Physiological responses	Linked to others	Physiological reactions to experiences (e.g. stress, shaking or crying)

Themes representing mastery experiences formed the biggest category that rose from the data, with 163 segments identified as related to mastery experiences. The category consists of

segments describing events and situations where students' self-efficacy beliefs were influenced by mastery experiences over the project work. These events can be divided to *soft* or *hard skill mastery* experiences that were faced *individually* or *collectively* as a team, these could be events such as workshops. In addition, *former mastery experiences* were mentioned as a base for confidence in product development prior to the beginning of the course. Teamwork was described as exciting and motivating. More important than concrete work was working together with ones team and having mutual experiences of accomplishment. In the following quote a student describes an event where hard skills were utilized but teamworking felt like a source for confidence:

"...Best thing was being together as a team since also the remotes were able to participate. It also increased my confidence on our project. Everybody was super motivated and working really hard for that day. That kind of efficient and positive sprit was "contagious" and I think our team hasn't been that effective ever since. It would be difficult to exceed that performance..." (example segment from category of mastery experience, subcategory of collective softskill mastery)

Vicarious experiences the interviewees described (n=64) were divided to *capability*, *attitude* and *performance*. Vicarious experiences were emerging from own teams but also from the other teams. The students compared their capability, attitude and performance to others' both on individual and team level in good and bad. Comparisons of attitude and commitment were mostly made within the interviewees' own team and often described as contagious feelings that either enhanced or decreased the level of commitment and excitement within the team. Interviewees were often assuming their own team's performance being poor compared to others, and they also perceived their project brief being more complex than the other teams' briefs. They also compared their performance to the course schedule and often described how they were behind from the schedule. In a quote above self-efficacy beliefs were damaged by comparing teams own capability vicariously to competence of the industrial definer of the sponsoring company:

"...I'm not surprised that he (the sponsor representative) quit working for the company. I found his product designs cool but those never went to manufacturing. If you are an industrial designer, that must be frustrating. How could we ever design anything meaningful if even he couldn't do it?..." (example segment from category of vicarious experience, subcategory of comparison of capability)

The segments categorized into category 3, social persuasion (n=99), described experiences regarding *verbal* and *non-verbal feedback* and sometimes *the lack of feedback*. The interviewees described searching for feedback from and discussing their projects with different stakeholders. They presented their ideas and concepts as well as showed and tested prototypes with users, customers, course staff etc. Fellow team members were described as a main source of feedback. However, representatives of the sponsoring company were described to having had the strongest influence on the interviewees feeling of accomplishment, both in good and bad. Other project stakeholders and their feedback were rarely described as having as strong influence. They also turned to outside sources for affirmation and experienced the feedback to be useful is the outsider could be seen as an expert of the field in question. This feedback helped the teams to move forward with their project in situations where they otherwise would have stalled. If the teams were lacking feedback from the sponsor towards the end, the interviewees solely experienced it as a sign of

incompetence. For example, one student describes how it was difficult to move on with the project due to lack of feedback from the sponsor.

“...It’s a bit difficult to get motivated since we don’t get any feedback from the sponsor. I mean we have couple of potential concepts but at least I’m not confident to proceed since I don’t know what the sponsor thinks...” (example segment from category of social persuasion, subcategory of lack of feedback)

The interviewees also described *emotional* and *physiological* responses to different events while working on their projects. However, these responses were always related to other categories as well. Emotional responses could be seen to work as catalyst and confirmation for experiences the interviewees regarded as influential to them. Emotional responses were occurring regularly in the data and the interviewees described both positive and negative emotions. They made assumptions of others’ emotions and reflected on their own emotions. Even experiences of failure helped the students work resiliently if positive emotions were related to those experiences. The segments described both milder and stronger emotional experiences, e.g. frustration that did not quite lead to any change or specific actions as well as anger or bursts of emotion. Only a few physiological response-involving experiences were described in the interviews and they only emerged in situations where students were describing perceived stress or nervousness. They described having trouble sleeping, or feeling stressed due to a busy schedule for instance. In the following quote, a physiological response caused by nervousness is presented. However, this experience was also categorized as a mastery experience of storytelling.

“...I don’t usually mind about giving presentations. Though, I have to say that I was super nervous when I was performing during halfway show. Standing at stage in spotlight made my heart beat and I was probably shaking. There was 200 people watching us which was both exciting but a bit scary at the same time...” (example segment from category of physiological and emotional arousals, subcategory of physiological responses also mastery experience and subcategory of softkill mastery)

4 DISCUSSION AND FUTURE RESEARCH

In this study we explored the possible relation between Bandura’s model and theory of self-efficacy and the theory of entrepreneurial motivations in the context of a multidisciplinary product development project-course (Bandura, 1977, 1997). We aimed to learn what kinds of situations affected the self-efficacy beliefs of team members during the course and how interaction and emotions affect the perceived self-efficacy. Mastery experiences was found to be the biggest category resultwise. Vicarious experiences were emerging from own teams but also from the other teams. In terms of social persuasion company representatives had the strongest influence on the interviewees feeling of accomplishment. Emotional and physiological was a meta category in a sense that the responses were always related to other categories.

The focus of the research was to identify specific situations in which the self-efficacy of team members was influenced, as well as the role of emotions and interactions in those situations. By reviewing raw interview data categories were generated under each main source of self-efficacy as seen in Table 1. Before taking the course, students were basing their self-efficacy beliefs on product development to their former professional experiences, study background and to experiences of course alumni. The students seemed to be confident to succeed in class.

This is aligned with prior research showing that self-efficacy beliefs affect people's choices in life (Bandura 1977, 1997). Bandura's self-efficacy theory suggests that students may have had selected the product development project -class due to their high beliefs of success (Bandura 1997). Experiences during the project work were much more influential for perceived self-efficacy than former experiences prior the course. Once the projects started, the most influential source of perceived self-efficacy was *individually or collectively experienced mastery of soft skills often related to creativity and team working skills*. In addition, self-efficacy beliefs were affected by *performance comparisons* to other teams as well as the "contagious like" attitude of fellow team members.

4.1 Team as the main reference group

The results show that the team itself is the core of both individual and collective self-efficacy. Active team dynamics and promotion of open communication and feedback was found important. Feelings and attitudes are contagious among team members. For instance, if half of the team appears to be uncommitted to the project work the rest of the team is affected as well. On the other hand, collectively experienced moments of success can result as enhanced self-efficacy on an individual level.

Performance comparisons were often related to situations or project phases where students felt uncertain or inefficient. The assumption-based comparison had solely negative effect on team's efficacy beliefs. Positive effects from performance comparisons were only experienced during a situation where teams were openly speaking about their project progress and difficulties during the autumn term. This gives cause to argue that during a capstone course teams can have strong influence on each other in terms of perceived self-efficacy. Thus, cross-team activities should be supported in order to enhance positive efficacy beliefs in terms of these experiences and to avoid negative ones.

Perceptions of incompetence occurred at the phase where the teams had already gained a vast knowledge about their project topic. Background research phase generated restrictions to concepts and new questions that needed to be answered. It would be logical to assume that the more experienced you become the better self-efficacy beliefs you would have, but in case of the researched student teams it seemed to work vice versa.

4.2 Results reflected through theories of entrepreneurship

Similarly to PDP students, entrepreneurs strive on finding confirmation and appreciation towards their ideas and prototypes. Entrepreneurial behavior, which refers to one's capability on recognizing and exploiting new business opportunities, is a crucial part of entrepreneurial intentions. (Bird & Schjoedt, 2009) As seen in interviews, students are practicing similar behavior while working with given design briefs. Students need to use variety of creative methods in order to find root causes of given product design problems in order to come up with innovative solutions.

Entrepreneurial intentions refer to one's capability and willingness to start their own venture (Lee et. al, 2011). The prior research on entrepreneurial self-efficacy suggests that individuals with higher efficacy beliefs are more likely to take actions towards entrepreneurial intentions. This suggests that positive influence on perceived self-efficacy in product development activities can enhance adaptation of entrepreneurial behavior.

This particular research about perceived self-efficacy among product development teams cannot prove that students would be more ready or willing to start their own ventures after participating the course. However, the research reveals various events where students' entrepreneurial capabilities are enhanced. As stated earlier, product development has almost identical stages with new venture creation during the early phases of the process. Students often described that the course was their first practical project work experience that especially required various team work related soft skills in order to succeed. Since this kind of practical project work experience during early phases of product development is also vital in new venture creation, the course can be seen as an enhancing experience for entrepreneurial capability.

Bandura's original theory suggests that self-efficacy experiences may have long-term influences that become visible years after the actual experience. It would be interesting to interview same students again several years after completing the course and ask them to reflect the most influential experiences that they had during the course. Longitudinal study could reveal other significant situations that had strong influence on individual's perceived self-efficacy in a long term. Therefore, natural implication for further research would be to map out the most influential experiences during product development project that had a long-term effect on perceived self-efficacy.

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